



Thailand  
ENVIR



Air Quality

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MONITOR 2002

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November  
2002



**Thailand Environment Monitor 2000**  
presented a snapshot of general environmental trends in the country.



**Thailand Environment Monitor 2001**  
Assessed the status of water quality management in the country.

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The Pollution Control Department in the Ministry of Natural Resources and Environment; the World Bank; and the United States-Asia Environmental Partnership contributed to the preparation of this document. The World Bank Team consisted of Anjali Acharya, Jenna Diallo, Surhid Gautam, Patchamuthu Illangovan, Sirinun Maitrawattana, Emily Manchee, Tanvi Nagpal, Nat Pinnoi, Phil Sayeg, Jitendra Shah (Team Leader), Manida Unkulvasapaul, Sutthana Vichitrananda, and Hua Wang. Jack Kneeland and Saengroaj Srisawaskraisorn represented the United States-Asia Environmental Partnership. Dr. Supat Wangwongwatana, Mingquan Wichayarangsrich, Janejob Suksod, Panya Warapetcharayut, Phunsak Theramongkol, Seksan Sangdow and Supap Chunhong represented the Pollution Control Department. The document was peer reviewed by Edward Dotson and Todd Johnson. Sirinun Maitrawattana coordinated the production of this Monitor. Katherin Golitzen provided editing support and Jeffrey Lecksell was responsible for map design. Yok Dechamorn and Sorachai Nanthawatcharawiboon prepared the cover design and layout.

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The Thailand Environment Monitor series tracks key environmental trends in the country. Its aim is to engage and inform stakeholders on key environmental changes and challenges as they occur. The 2000 Monitor benchmarked general environmental indicators, while the 2001 Monitor focused on water quality. This year, the Monitor concentrates on air quality.

Vehicles, power plants, factories, forest fires, agricultural burning and open cooking all contribute to air pollution in Thailand. While air pollution certainly has regional and global implications, its most severe impacts are felt by people living in cities, where concentrations are higher. Air quality monitoring measures the principal pollutants, including particulate matter, nitrogen oxides, ground-level ozone, carbon monoxide, sulfur dioxide, and lead. Much of the air quality monitoring information used in this document is drawn from the Pollution Control Department's monitoring network.

Economic and other activities in and around transport corridors result in a high incidence of pollution-related health problems in Thailand's cities. Several studies demonstrating the ill effects of air pollution on human health in Thailand have served as an important wake-up call. A decade ago, the health costs of exposure to lead, particulate matter, and carbon monoxide in Bangkok were estimated to be equivalent to between 8 and 10 percent of urban annual income.

The many commendable initiatives taken by the country include: enacting the environmental law in 1992; completing the phase-out of leaded gasoline by 1995; improving fuel quality and engine specification; curbing pollution from power plants; moving enterprises to cleaner production practices; tightening construction standards; improving public transport; and substantially reducing the use of ozone depleting substances. As a result of the improvements in air quality, air pollution costs to the national economy are now estimated to be equivalent to 1.6 percent of the GDP, down from 2.6 percent five years ago.

On the global level, Thailand has demonstrated its commitment by ratifying the Kyoto and Montreal Protocols, among other conventions.

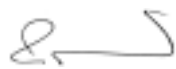
The Constitution of 1997 provides opportunities for civil society and the private sector to play an expanded role in environmental protection, including air quality management. Government agencies should harness this additional capacity while improving coordination among themselves. A multi-stakeholder partnership approach would benefit Thailand as it begins tackling the next set of challenges in attaining bluer skies.

The 2002 Environment Monitor comprises seven sections. The *first two* sections after the summary deal with the sources of pollution, and the monitoring of air quality. The *third* section describes the trends for different pollutants. The *fourth* section estimates health and non-health impacts of air pollution along with the public perception, while the *fifth* section deals with various policy responses taken to address air quality issues. The *sixth* section focuses on environmental management (legislation, institutions, and budget) pertaining to air quality management. The *final* section presents the main air quality challenges.

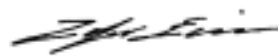
This Monitor is the outcome of a joint exercise. The Pollution Control Department provided data, reviewed the analysis, and coordinated inter-agency cooperation. The United States-Asia Environment Partnership supported the public perception survey undertaken by the Thai Society of Environmental Journalists. The World Bank team was responsible for analysis, report writing, and quality assurance. In addition, several national agencies, academics, civil society, and researchers participated in preparation of the Monitor. The information contained herein has been compiled from a variety of sources, including published and unpublished data and reports of Government agencies, universities, nongovernmental organizations, individuals, the World Bank, and international partners.



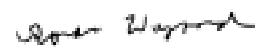
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## ABBREVIATIONS & ACRONYMS

AQI	Air Quality Index	MoTC	<i>former</i> Ministry of Transport and Communications
BMA	Bangkok Metropolitan Administration	MP	Montreal Protocol
BMR	Bangkok Metropolitan Region	MT	Metric tons
BMTA	Bangkok Metropolitan Transit Authority	NEB	National Environment Board
BTS	Bangkok Transit System	NEPO	<i>former</i> National Energy Policy Office
CDM	Clean Development Mechanism	NEQA	National Environmental Quality Act
CFC	Chlorofluorocarbons	NO	Nitric oxide
CH <sub>4</sub>	Methane	NO <sub>x</sub>	Nitrogen oxides
CO	Carbon monoxide	NO <sub>2</sub>	Nitrogen dioxide
CO <sub>2</sub>	Carbon dioxide	NGO	Nongovernmental organization
DEDP	<i>former</i> Department of Energy Development and Promotion	O <sub>3</sub>	Ozone
DIW	Department of Industrial Works	ODS	Ozone depleting substances
EGAT	Electricity Generating Authority of Thailand	OPPMO	Office of the Permanent Secretary, The Prime Minister's Office
ESP	Electrostatic precipitators	Pb	Lead
FGD	Flue Gas Desulfurization	PCD	Pollution Control Department
GDP	Gross Domestic Product	PM <sub>10</sub>	Particulate matter smaller than 10 microns
Gg	Giga grams = 1015 grams	PM <sub>2.5</sub>	Particulate matter smaller than 2.5 microns
GHG	Greenhouse gas	POP	Persistent organic pollutants
HC	Hydrocarbon	ppb	Parts per billion
HOV	High Occupancy Vehicle	ppm	Parts per million
I/M	Inspection and maintenance	SO <sub>2</sub>	Sulfur dioxide
IPP	Independent Power Producers	SPP	Small power producers
LTD	Land Transport Department	TSP	Total suspended particulates
LPG	Liquefied petroleum gas	µg	Micrograms
mg	Milligrams	µg/m <sup>3</sup>	Micrograms per cubic meter
mg/m <sup>3</sup>	Milligrams per cubic meter	ULG	Unleaded gasoline
MLF	Multilateral Fund (GEF)	UNFCCC	United Nations Framework Convention on Climate Change
MoE	Ministry of Energy	US-AEP	United States – Asia Environmental Partnership
MoIND	Ministry of Industry	USEPA	United States Environmental Protection Agency
MoNRE	Ministry of Natural Resources and Environment	UV	Ultraviolet
MoPH	Ministry of Public Health	VOC	Volatile organic compounds
MoSTE	<i>former</i> Ministry of Science, Technology and Environment		

**Exchange Rate: US\$ 1 = Baht 43.58**  
(as of November 30, 2002)



IBRD 32163



DECEMBER 2002



# SUMMARY

## Thailand's Air Quality : At Crossroads

Thailand has made remarkable progress over the past decade in combating air pollution. Today, Bangkok's air quality ranks ahead of Beijing, Jakarta, New Delhi, and Manila, but lags behind other cities such as Hong Kong, Singapore, Taipei, and Tokyo. While overall air quality has improved, it is still a problem in traffic corridors and urban centers like Bangkok.

Key air pollutants include dust, small particulate matter (PM<sub>10</sub> and PM<sub>2.5</sub>), sulfur dioxide (SO<sub>2</sub>), lead (Pb), carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), hydrocarbons (HC), and ground-level ozone (O<sub>3</sub>). Other transboundary air pollutants such as ozone depleting substances (ODS), greenhouse gases (GHG), and some persistent organic pollutants (POPs) have caused long term impacts on the regional and global environment.

In Thailand, motor vehicles, power plants, factories, construction, forest fires, agricultural burning and open cooking all contribute to the emission of these pollutants. Among transport sources, two-stroke motorcycles, diesel trucks and aging buses are contributing significantly to air pollution in urban areas. The Central Region in Thailand accounts for 60-70 percent of all industrial emissions in the country. Fossil fuel-powered thermal sources continue to generate SO<sub>2</sub>, NO<sub>2</sub> and carbon dioxide (CO<sub>2</sub>) emissions, while PM emissions from power plants have been curbed. In non-urban areas, sources such as agricultural burning also contribute significantly to particulate pollution.

Trends in the ambient levels of these air pollutants can be gauged through appropriate and systematic monitoring. In Thailand, the air quality monitoring system is well developed. The Pollution Control Department (PCD) has taken the lead in monitoring key air pollutants, establishing ambient standards, and recommending policy measures to reduce air pollution in critical areas. The PCD's monitoring network consists of 71 sites nationwide—37 located in Bangkok and 11 in the suburbs. Much of the information presented in this report is based on PCD data.

Results of air quality data captured at these monitoring stations reveal that most air pollutants are declining.

**Table 1. Thailand's National Primary Ambient Air Quality Standards in µg/m<sup>3</sup>**

Pollutant	Averaging time	Standard or Guideline µg/m <sup>3</sup>		
		Thailand	USEPA	WHO
TSP	Daily	330		- <sup>2</sup>
	Annual	100 <sup>1</sup>		
PM <sub>10</sub>	Daily	120	150	- <sup>2</sup>
	Annual	50 <sup>1</sup>	50	
Pb	1-month	1.5		
O <sub>3</sub>	Annual			0.5
	1-hour	200		
SO <sub>2</sub>	8-hours			120
	Daily	300	365	125
NO <sub>2</sub>	Annual	100	80	50
	1-hour	320		200
CO	Annual		100	40
	1-hour	34.2K	40 K	30 K
	8-hour	10.26 K	10 K	10 K

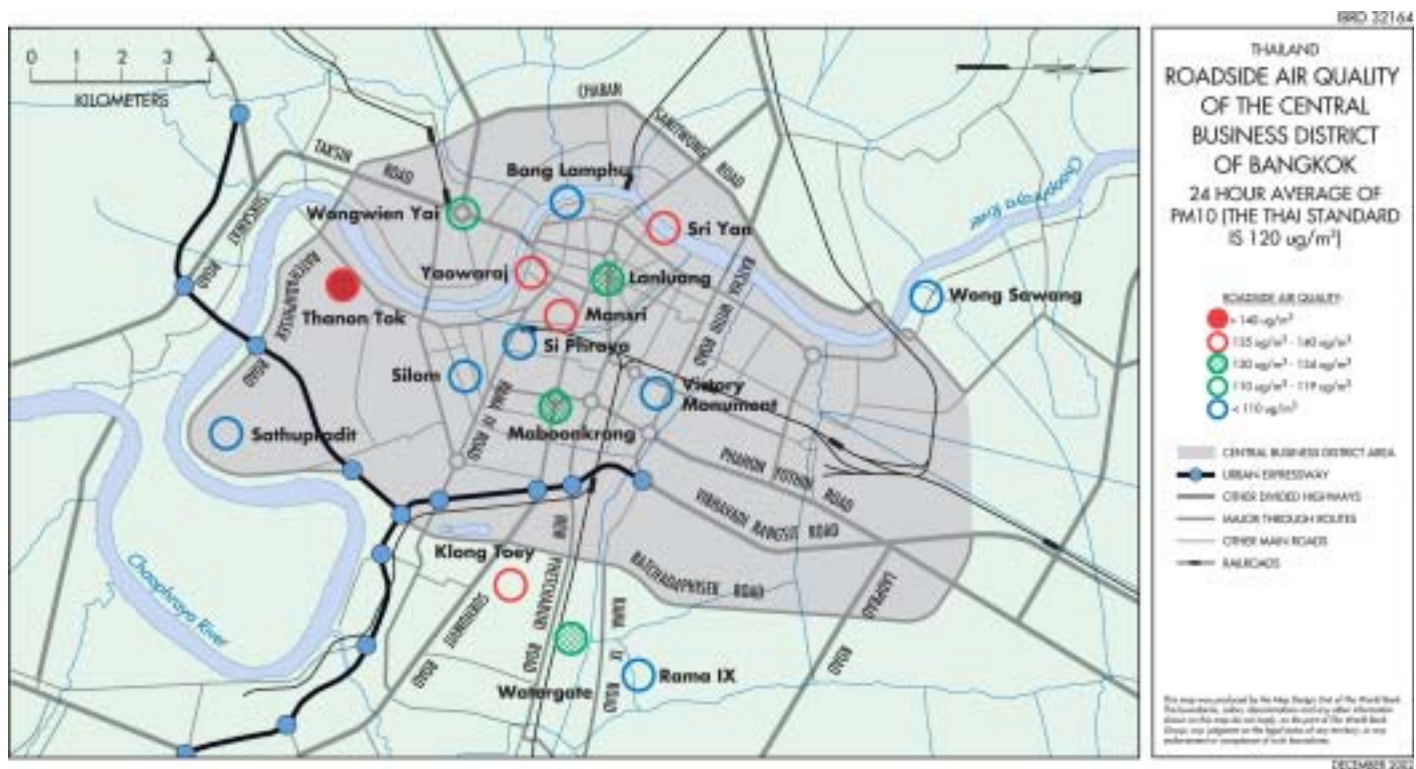
Source: PCD, WHO/SDE/OEH/00.02, Geneva 2000.

Notes:

1. Geometric mean.
  2. WHO no longer recommends air quality guideline for PM because there is no safe lower limit for PM.
- Values of USEPA are for primary standards.
  - Annual average -- average of daily measurements taken over one year.
  - µg/m<sup>3</sup> is a unit of measurement and refers to one millionth of a gram of a pollutant in a cubic meter of air at 25 degrees Celsius at 1 atmosphere.
  - Guideline refers to the safe level of a pollutant, for the given averaging time, to protect the public from acute health effects.
  - CO values are in 1000 (K) of µg/m<sup>3</sup>.

With the Government's efforts and leadership, the ambient levels of key pollutants—Pb, particulates, SO<sub>2</sub> and CO—in Bangkok and other urban centers have fallen dramatically. With the exception of particulates and O<sub>3</sub>, all pollutants now comply with the country's air quality standards (Table 1).

Ambient PM, the pollutant with the most serious health impacts, still exceeds standards along traffic corridors. This is particularly serious along roadsides in urban areas such as Bangkok (See Map).



Visibility measurements at Don Muang airport in Bangkok have improved since 1996, even as improvements are reported in  $\text{PM}_{10}$  levels. Concentration levels of  $\text{NO}_x$  and CO are stable and declining, respectively.  $\text{SO}_2$  levels too have declined substantially as new technology is installed at the country's power plants. Ozone levels are causing concern, with maximum values exceeding the standard.

In terms of GHGs,  $\text{CO}_2$ , methane ( $\text{CH}_4$ ) and nitrous oxide contribute 68, 27 and 5 percent of total GHG emissions. Among sources, the energy sector in Thailand accounts for 51 percent of total emissions. Consumption of ODS has declined significantly over the last decade.

The presence of pollutants in the air contributes to numerous health effects ranging from irritation and odor to acute and long-term lung impairment and cardiac problems. This then translates into health costs associated with mortality and morbidity from respiratory and other cardiopulmonary diseases. The drop in most pollutant levels in Thailand has resulted in declining health costs. Health costs are estimated to have halved in Bangkok during the past five years, but they still cost the equivalent of 1.6 percent of the Gross Domestic Product (GDP) annually.

Benefit-cost ratios on health issues associated with air pollution are encouraging. One study of air pollution management in Thailand has estimated that under a medium investment scenario, the total annualized costs of implementing air pollution controls would be US\$660 million in 2005 and US\$1.5 billion in 2020, with corresponding benefits of US\$4.7 billion and US\$25 billion, respectively.

Indoor air pollution, however, remains a concern. A recent study of indoor and outdoor exposure to small particulates in Bangkok concluded that daily fluctuations of PM concentrations are correlated with PM concentrations at both near and ambient locations. However, most indoor environments, including shops, living rooms, and bedrooms, had levels higher than ambient levels of both  $\text{PM}_{2.5}$  and  $\text{PM}_{10}$ .

Improvements in air pollutant levels in recent years can be attributed to the foresight and leadership of a few champions, policy corrections (e.g. engine and fuel quality standards and a shift to natural gas in the power sector), massive public spending in infrastructure, stepped-up enforcement, and the market's response to advanced technologies.

# SUMMARY

## Thailand's Air Quality : At Crossroads

In the transport sector, new cars pollute very little and motorcycles are increasingly four-stroke, though there remains a large fleet of older two-strokes. While newer EURO II buses have begun to ply the Bangkok streets, a very large fleet of older diesel buses and trucks still emits large amounts of carcinogenic particulate pollution.

The power sector is shifting more to natural gas and low-sulfur coal as fuel sources, and now requires sulfur dioxide scrubbers. At the same time energy efficiency measures and demand-side management are improving emissions from this sector. Many industrial units have embraced cleaner production to reduce air pollution, but emissions from small and medium-sized enterprises still remain a major problem. Crematoriums are being upgraded to reduce their contributions.

Area sources remain a major concern. In the countryside, open agricultural and forest burning is estimated to emit over 350,000 tons of PM annually. This smoke not only causes local impact, but is also a major source of cross-border pollution, especially from February to April. Open burning of garbage in Bangkok has decreased with the establishment of sanitary landfills.

The many improvements in pollutant levels do not seem to have changed the public's perception about air quality. A recent survey reported that three in four Bangkok residents viewed air pollution as the most significant pollution problem they faced. While air quality measurements reveal, and experts report, that Bangkok's air quality is getting better, the public remains skeptical. Such skepticism implies that public disclosure of Government programs and public participation in managing air quality may be inadequate or ineffective.

With several successes in addressing air pollution, the Government should now build on recent gains through an integrated program that involves all segments of society. Comprehensive environmental legislation in Thailand also contains specific articles and clauses addressing air quality. However the enforcement of laws remains weak due to inadequate political will, capacity constraints at the local level, lack of incentives and poor coordination among agencies.

In October 2002, a new Ministry of Natural Resources and Environment (MoNRE) was created to oversee environmental management, including air quality. This new Ministry creates an opportunity for improving coordination, integrating environmental functions across agencies, and enhancing service delivery.

In summary, Thailand needs to address the following major challenges in order to better manage its air quality over the coming decade:

- *Focusing on fine PM in Bangkok.* A recent action plan estimates that a 20 percent reduction from 1997 levels can be achieved by targeting diesel buses, and trucks at a cost of about US\$80 million, with corresponding benefits estimated at over US\$200 million.
- Improving air quality management by *strengthening analytical capability* in emissions inventory and health impact assessment, stepping up enforcement, and expanding monitoring and modeling.
- *Improving public transport and traffic management* by increasing the number of priority bus lanes, controlling smoke emissions from buses, and encouraging the use of the Skytrain.
- *Strengthening institutional effectiveness* by improving coordination among agencies and building capacity at the local level.
- *Broadening public involvement* in air quality management activities and improving public participation and disclosure.
- *Harnessing global opportunities* for local good by employing the Clean Development Mechanism (CDM) in the country.

Tackling these challenges, accompanied by better enforcement of environmental legislation and adequate budgets, will put Thailand on the right path towards attaining bluer skies.